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Thoracolumbar vertebral fractures in Sweden: an analysis of 13,496 patients admitted to hospital

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Abstract National Longitudinal data of thoracolumbar fracture incidence, trends or mortality rates are lacking. The correlation between admissions and operations of thoracolumbar vertebral fractures has not been investigated. The aim of our nationwide population-based epidemiological study was to analyse the incidence, admissions, operations, and case fatality rate among patients with thoracolumbar vertebral fractures admitted to hospital in Sweden. The Swedish Hospital Discharge Register (SHDR) and the Cause of Death Register (CDR) were linked to determine the incidence of surgical interventions, trends, characteristics of the patients, and case fatality rate for thoracolumbar vertebral fractures based on comprehensive national data. The annual incidence of thoracolumbar fractures was on average 30 per 100,000 inhabitants and did not change considerably during the study period. Among patients younger than 60 years of age the annual incidence was 13 per 100,000 and was twice as high in men compared to women. The proportion operated on was 15%. In the age-group 60 years and

older the majority were women. In this group two percent were operated on. However, males were operated on twice as often as women. The 90-day case-fatality rate after surgery was 1.4%. This information may assist health care providers in health care planning. Moreover, these data can also be used for power calculations when planning future clinical studies.

Keywords Case fatality rate · Epidemiology · Mechanism of injury · Population based study · Spine · Vertebral fractures

Abbreviations

CDR Cause of Death Register
ICD International Classification of Diseases
PIN Personal identity number
SHDR Swedish Hospital Discharge Register

Introduction

There are few international studies with population based data on the epidemiology of vertebral fractures. Most earlier epidemiological studies were retrospective case series or from single hospitals [1, 2]. In previous studies, the annual fracture incidence varied from 23 to 90 per 100,000 inhabitants [1, 3–9]. The Framingham cohort study included 5,209 patients with a mean age of 44 years (range 28–62 years) and a prevalence of vertebral fracture of 14% [8].

In Sweden, with a population of 9.2 million, about 2,700 patients with thoracolumbar vertebral fractures are admitted to hospitals annually. Most of these fractures are caused by blunt trauma [6, 7]. In younger patients, thoracolumbar

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vertebral fractures are usually caused by high energy accidents such as falls, or motor vehicle accidents whereas in elderly patients, osteoporosis is the dominant etiology [10]. Many patients have permanent functional impairment and pain. Long term reductions in quality of life and ability to work are frequent [10, 11].

Treatment of thoracolumbar vertebral fractures has been debated extensively [12–23]. Three comprehensive reviews of unstable traumatic thoracolumbar vertebral fracture management did not find any clear pattern in the relative merits of operative compared to non-operative treatment [13, 21, 22].

To our knowledge, previous studies have not investigated the proportion of patients admitted for thoracolumbar vertebral fractures and operated on. Therefore, the aim of our nationwide population-based epidemiological study was to analyse the incidence, admissions, operations, external causes, and case fatality rate among patients with thoracolumbar vertebral fractures admitted to hospital in Sweden.

Patients and methods

Sweden has a national public healthcare system, based on independent county councils, mainly financed by local taxes.

Since 1964, the Swedish National Board of Health and Welfare has compiled data on hospital discharges in the Swedish Hospital Discharge Register (SHDR) [24]. From 1997 onward all Swedish hospitals participate. Each record contains information about demographics, diagnoses, operations, and administrative data about the healthcare provider and the admission. Each year, about 1.3 million discharges are recorded. The validity of the data in the Register has previously shown to be adequate [25].

We identified all patients with a primary discharge diagnosis of thoracic or lumbar vertebral fractures, spine dislocations, or disc ruptures in the SHDR (ICD 10 S22.0, S22.1, S23.0, S23.1, S32.0, S32.1, S33.0, S33.1, International Classification of Diseases, 1997) [26]. Surgery in these patients was categorized by procedure codes indicating spine operations (NA* **), and operations on the nervous system (A** **; Nordic Classification of Operations and Major Procedures, 1997) [27]. The standard diagnostic workup was examination of clinical signs and radiological examination.

In order to assess survival, linkage was performed to the Swedish Death Register using the unique personal identity number (PIN) [28]. From this register, information was obtained about underlying cause of death, and date of death. All patients were followed from January 1, 1997 through December 31, 2001 or date of death. Both these registers are maintained by the Centre of Epidemiology,

National Board of Health and Welfare, Stockholm Sweden. (WWW.sos.se/epc/epceng.htm).

Age was categorized as 0–19, 20–29 years etc. and 80+ years. In the descriptive and multivariate analyses, patients were stratified by age 0–59 years or 60 years and older.

Causes of fractures were reported for 95% of the patients and were grouped into six categories by ICD E-codes (External causes).

All patients operated on during their first admission and, in addition, patients having a first admission without surgery but a second or a later admission with an operation were identified. No readmissions were counted. Indication for surgery was based on the clinicians' evaluations.

Cases fatality rates at 30 and 90 days were calculated at time at risk from the date of admission to the date of death.

The study was approved by the Regional Research Ethics Board (Dnr 04-530/5).

Statistical analyses

Incidence rates of thoracolumbar vertebral fractures and surgical procedures were calculated from the Swedish national and regional population in the year 2000 (Statistics Sweden) [24]. Only patients with complete records were included. Multivariate logistic regression analyses were performed to estimate the probability of surgery considering sex, age, primary diagnosis, external cause of fracture, year of operation, and geographic region. Odds ratios (OR) and the corresponding 95% confidence intervals were calculated.

Results

The study base consisted of 13,496 admitted patients. Of these, a third (34%) was aged 0–59 years (Table 1a) and a majority was men (62%). The most frequent external causes were transport accidents and falls from heights.

Among the 4,530 patients aged 0–59 years, 684 patients (15%) were operated on. Surgery was most frequent in the patients 20–39 years of age. The crude annual proportion operated on decreased over the study years.

The 8,966 patients 60 years or older (Table 1b) constituted two-thirds of the study population (66%), and two-thirds were women (68%). More than half of the patients were 80 years or older, the majority with lumbar vertebral fractures, most of them caused by falls at the same level. The crude annual number of patients admitted decreased slightly over the study years.

Operations were uncommon in these older patients (2%). It was four times more frequent in men than in women (4 vs. 1.0%) and most operations were performed

Table 1 Thoracolumbar fractures in Sweden 1997–2001

	Admissions		Surgery	
	<i>N</i>	% Of total	<i>N</i>	% With surgery
<i>A. Patients 0–59 years n = 4,530</i>				
Sex				
Male	2,801	61.8	426	15.2
Female	1,729	38.2	258	14.9
Age (years)				
0–19	624	13.8	68	10.9
20–29	932	20.6	174	18.7
30–39	839	18.5	153	18.2
40–49	921	20.3	129	14.0
50–59	1,214	26.8	160	13.2
Diagnosis				
Thoracic vertebral fracture	1,971	43.5	236	12.0
Lumbar vertebral fracture	2,559	56.5	448	17.5
External cause				
Falls same level	712	15.7	75	10.5
Falls from heights	1,076	23.8	181	16.8
Falls not specified	297	6.6	33	11.1
Transport accidents	1,753	38.7	281	16.0
Miscellaneous	489	10.8	79	16.2
None reported	203	4.5	35	17.2
Year				
1997	877	19.4	147	16.8
1998	955	21.1	153	16.0
1999	902	19.9	124	13.7
2000	873	19.3	138	15.8
2001	923	20.4	122	13.2
Region				
Southern	805	17.8	137	17.0
Western	775	17.1	93	12.0
South–East	502	11.1	75	14.9
Stockholm	798	17.6	149	18.7
Central	949	20.9	133	14.0
Northern	686	15.1	96	14.0
Missing data	15	0.3	1	6.7
Total	4,530	100.0	684	15.1
<i>B. Patients 60-years n = 8,966</i>				
Sex				
Male	2,891	32.2	113	3.9
Female	6,075	67.8	59	1.0
Age (years)				
60–69	1,311	14.6	91	6.9
70–79	3,051	34	59	1.9
80–	4,604	51.3	22	0.5
Diagnosis				
Thoracic vertebral fracture	3,383	37.7	57	1.7

Table 1 continued

	Admissions		Surgery	
	<i>N</i>	% Of total	<i>N</i>	% With surgery
Lumbar vertebral fracture	5,583	62.3	115	2.1
External cause				
Falls same level	5,275	58.8	50	0.9
Falls from heights	710	7.9	53	7.5
Falls not specified	1,426	15.9	19	1.3
Transport accidents	380	4.2	22	5.8
Miscellaneous	697	7.8	23	3.3
None reported	478	5.3	5	1.0
Year				
1997	1,895	21.1	22	1.2
1998	1,951	21.8	27	1.4
1999	1,754	19.6	28	1.6
2000	1,760	19.6	46	2.6
2001	1,606	17.9	49	3.1
Region				
Southern	1,749	19.5	36	2.1
Western	1,661	18.5	31	1.9
South–East	934	10.4	11	1.2
Stockholm	1,545	17.2	38	2.5
Central	1,905	21.2	29	1.5
Northern	1,161	12.9	25	2.2
Missing data	11	0.1	2	18.2
Total	8,966	100.0	172	1.9

Characteristics of admissions and operations

in patients 60–69 years of age. The crude annual proportion of patients operated on increased each year.

To accommodate the impact of each variable on the probability of spine surgery, a multivariate analysis was performed for the two age groups (Table 2). In patients 0–59 years of age at surgery, we found no difference between sexes but the probability was significantly higher in the youngest patients from 21 to 39 years of age. Patients with thoracic fractures had a lower probability than those with lumbar fractures. Patients who had fallen from heights or were injured by transport accidents had an increased probability. The probability of surgery was lowest in the western region. There were no changes over time.

In patients 60 years or older, men had a significantly higher probability of an operation than women, and the probability decreased steeply with increasing age. The highest probability was seen in patients who had fallen from heights or suffered from transport accidents. The probability increased significantly during the last 2 years. There were no significant differences between geographical regions.

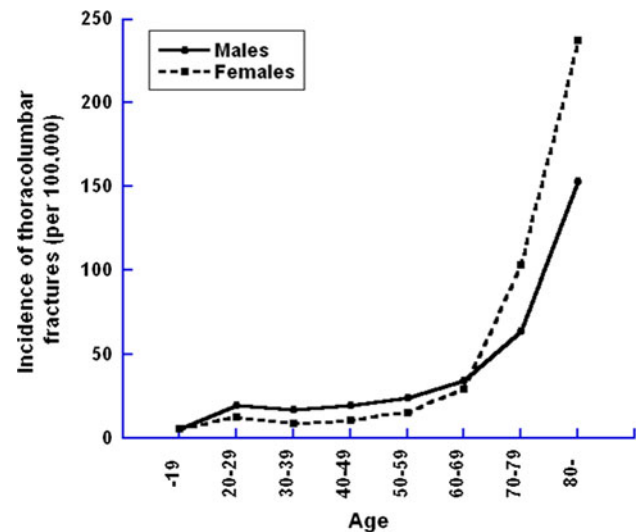
Table 2 Thoracolumbar vertebral fractures in Sweden 1997–2001

	0–59 years		60+ years	
	OR	95% CI	OR	95% CI
Sex				
Female	1.00	Ref.	1.00	Ref.
Male	0.98	(0.82–1.16)	2.42	(1.70–3.45)
Age (years)				
≤ 20	1.00	Ref.		
21–29	1.83	(1.34–2.50)		
30–39	1.77	(1.28–2.43)		
40–49	1.31	(0.94–1.81)		
50–59	1.24	(0.90–1.69)		
60–69			1.00	Ref.
70–79			0.42	(0.30–0.61)
80–89			0.14	(0.08–0.23)
Diagnosis				
Lumbar vertebral fracture	1.00	Ref.	1.00	Ref.
Thoracic vertebral fracture	0.65	(0.55–0.77)	0.73	(0.52–1.03)
External cause				
Falls same level	1.00	Ref.	1.00	Ref.
Falls from heights	1.59	(1.19–2.14)	3.32	(2.13–5.19)
Falls not specified	0.96	(0.62–1.50)	1.36	(0.79–2.37)
Transport accidents	1.44	(1.09–1.90)	2.92	(1.67–5.12)
Miscellaneous	1.52	(1.07–2.15)	2.71	(1.59–4.60)
None reported	1.73	(1.10–2.71)	1.11	(0.43–2.88)
Year				
1997	1.00	Ref.	1.00	Ref.
1998	0.99	(0.76–1.28)	1.07	(0.59–1.93)
1999	0.83	(0.63–1.09)	1.37	(0.77–2.44)
2000	1.02	(0.78–1.32)	2.19	(1.29–3.71)
2001	1.03	(0.79–1.35)	2.93	(1.73–4.97)
Region				
Southern	1.00	Ref.	1.00	Ref.
Western	0.61	(0.45–0.82)	0.93	(0.56–1.55)
South-East	0.75	(0.54–1.03)	0.54	(0.26–1.09)
Stockholm	1.05	(0.81–1.37)	1.21	(0.74–1.96)
Central	0.74	(0.56–0.97)	0.60	(0.35–1.00)
Northern	0.73	(0.55–0.98)	0.73	(0.42–1.27)

Probability of spine surgery Odds ratios (OR) and 95% confidence intervals (95% CI)

The operations were mainly performed at university or regional hospitals (83% of the admissions), and most patient were discharged from departments of orthopaedic surgery (85%). The median length of stay was 8 days, changing only slightly during the study period.

Among those who were operated the 30 day case fatality rate was 0.7% and the 90-day case fatality rate was 1.4%. Median age for those who died was 64 years (Range 44–83 years). Common underlying causes of deaths were

**Fig. 1** Thoracolumbar vertebral fractures in Sweden 1997–2001. Age and sex specific incidence per 100,000 population**Table 3** Thoracolumbar vertebral spine fractures in Sweden 1997–2001

Age	Fractures			Operations		
	0–59	60–	All	0–59	60–	All
Year						
1997	12.7	97.2	31.3	2.1	1.1	1.9
1998	13.8	99.7	32.8	2.2	1.4	2.0
1999	13.1	89.3	30.0	1.8	1.4	1.7
2000	12.6	89.0	29.6	2.0	2.3	2.1
2001	13.2	80.5	28.2	1.7	2.4	1.9
Region						
Southern	12.1	88.2	29.6	2.1	1.8	2.0
Western	13.3	101.2	32.7	1.6	1.9	1.7
South-East	13.4	81.6	29.4	2.0	1.0	1.8
Stockholm	10.6	88.1	25.2	2.0	2.2	2.0
Central	12.9	85.0	29.7	1.8	1.3	1.7
Northern	20.1	108.9	41.3	2.8	2.3	2.7

Annual incidence of fractures and operations per 100,000 population

suicides, intoxications and accidents (29%), cardiovascular diseases (27%), and tumours (12%).

The average annual incidence of patients admitted to hospital with thoracolumbar vertebral fractures was 30.4 per 100, 000 person year (Fig. 1). In patients younger than 60 years of age, the incidence was 13 and twice as high in men as in women. The incidence increased steeply with age and in patients 60 years or older, it was higher in women than in men.

The annual incidence decreased slightly from 1997 to 2001 (Table 3). In patients 59 years or younger, the incidence was stable but decreased by 21% in older patients. The incidence was higher in the South-Eastern and

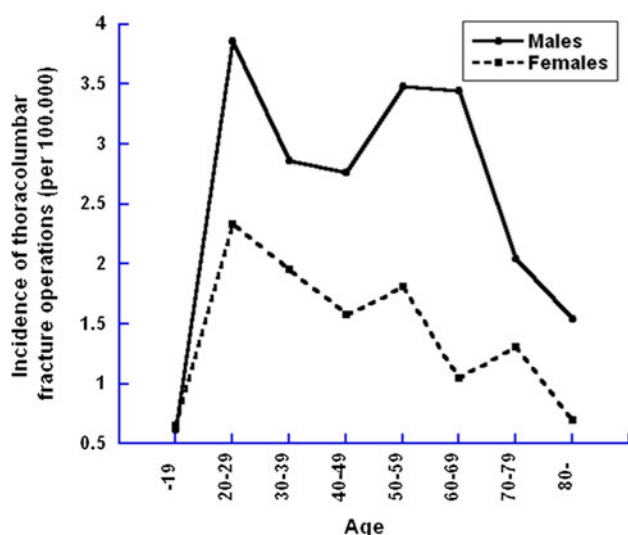


Fig. 2 Thoracolumbar vertebral fractures in Sweden 1997–2001. Age and sex specific surgical incidence per 100,000 population

Northern regions. The annual incidence of operations was 2 per 100,000 person and year with small changes over the study years. The incidence of operations was highest in the Northern region, was twice as high in men as in women, and decreased with increasing age (Fig. 2).

Discussion

In our study the incidence of thoracolumbar fractures was 13 per 100,000 inhabitants per year in patients younger than 60 years of age, and twice as common in men as in women.

Transport accidents and falls from heights were frequent causes. One patient in seven was operated on, and the probability was unchanged over the study period. Patients older than 60 years of age were mainly women, and only two percent were operated on. Males were operated on twice as often as women and the most common accidents were falls on a level. The probability of an operation increased the last two study years. The case fatality rate was very low.

In contrast to our study a Finnish study conducted 1970–1995 predicted the overall fall-induced fracture incidence in the population older than 50 years to be 32 per 100,000 in 2010 [7]. The study design was different comparing patients aged 50 years or older to a reference group of patients aged 20–39 years. The time period differed, 1970–1995, from which they made further prognosis. Another study performed in an earlier time period with long term follow-up, also reports higher incidences [8]. The low incidence figures in our study could be due to the fact that the total incidence of

vertebral fractures remains largely underestimated. A population based study showed that only about one-third of vertebral fractures comes to medical attention, whereas the majority remains unnoticed [5]. However, our study design was unable to detect these asymptomatic osteoporotic fractures. Only large population-based cohort studies which screen all participants would be able to elucidate this aspect. Up to 35% of unreported osteoporotic vertebral fractures coming to attention as incidental findings in imaging studies [29]. This figure reflects the low reporting rates by interpreting radiologists. Bartalena T et al. reported that only 15% of vertebral fractures had been noted in the radiology final report, most likely because of unawareness of their clinical importance [30].

In general clinical practice, subjective visual diagnostic methods are used. However, these are considered as being not reproducible enough for epidemiological studies [31]. Also, usually the more severe fractures tend to come to attention in clinical practice. Mild fractures are also of clinical importance despite being under diagnosed [32].

Many patients with thoracolumbar vertebral fractures may be treated on an out-patient basis. Richard Hu et al. [2] showed that a large percentage of all osteoporotic fractures were treated as out-patients. In our study we did not capture the patients treated as outpatients. We had only information on the patients discharged from hospitals. Also a few patients who died prior to admission to hospital could be missed. However, in the year 2007 there were only 4 patients out of 91,820 deaths in Sweden who had vertebral fracture as underlying cause of death [24]. These injuries could also be missed in polytrauma patients. However, the vast majority of thoracolumbar vertebral fractures due to high energy trauma are diagnosed and treated as in-patients.

We can only speculate regarding which factors contribute to the decreased incidence in our study. Many accident prevention programs have been launched in several areas, i.e. road safety, leisure time accident prevention training, fall prevention devices in geriatric care and pharmacologic prophylaxis against osteoporosis.

In order to include all potential thoracolumbar spine fractures we include disc ruptures. It is of course questionable if these can be counted as thoracolumbar fractures. However, we found only 8 patients per year ($=0.03\%$) with that diagnose. The reason for including sacral fracture in the study was that in axial trauma an spinopelvic dissociation can arise associated with lumbar spine surgery. This injury should strictly be defined as a pelvic or lumbosacral injury. This leads to a thoracolumbar fracture overestimation of 0.6%.

A major strength of our study is the calculation of population based incidence rate of fractures and surgical

procedures based on nation wide and complete in patient registration systems.

During the duration of this study, we observed an increasing incidence of operations among patients older than 60 years. A possible explanation of this could be the introduction of new surgical methods [33].

We found that the probability of surgery was lower among women compared to men. The influence of sex and gender on musculoskeletal health has been reported by Tosi et al. [34] who discussed the biological basis for differences in injury mechanism, pain sensation, drug handling, and healing response that cannot be explained simply by hormone levels.

Patients of male sex, younger age, high-energetic trauma or with lumbar fractures had an increased probability of surgery. In patients with spinal cord injury the mean age is around 30 years and 80% of them are men [35]. This figure indicates that high-risk behaviour is more common among young men. High-energetic trauma is strongly related to more severe vertebral injury and subsequently a higher indication for surgery. Even in patients older than 60 men have high risk behaviour falling from heights or have more transport accidents. Most fracture occurs in the lumbar region (thoracolumbar), whereas the thoracic cage does not protect the spine as well [36].

The study also showed signs of regional differences in the incidence of operations. The data may reflect considerable regional differences in treatment strategies among spine surgeons. The optimal treatment of patients with spinal fracture has been debated for years, and numerous studies have been published [16, 18, 21, 22].

As opposed to common belief in the medical community the study reported low case fatality rates in our surgically treated cohort (90-day 1.4%) [2]. An explanation could be that these patients are healthier than the general population or by advances in the perioperative management. In previous studies the case fatality rate was calculated at time at risk. This loses 1/12 in the tail-end and that would not influence the results.

Unfortunately we did not include co-morbidity or co-existing injuries in our study. Therefore, the relative risk of dying could have been higher in patients who were not operated on. Others have shown that the relative risk of death was very high in young individuals and decreased in both sexes with age [37]. The reason for this is not known but may be related to severe trauma injuries or other significant co-morbidity. Our analyses of the case fatality rate was limited to patients operated on and could therefore be a source of bias because very severe co-morbidity could have been a contra-indication for surgical intervention.

Kanis et al. showed excess mortality after hospitalization for all vertebral fractures in Sweden between the years 1987 and 1996 [37]. In comparison to our cohort, they

included only patients older than 50 years. They reported that the risk of death was markedly increased immediately after the event of the vertebral fracture. After a short period of declining risk, the risk increased with age at a rate which was higher than that of the general population and comparable to the rate that 1 year after a hip fracture. The latter function was assumed to be due to deaths related to co-morbidity and the residuum assumed to be due to the vertebral fracture.

Our study includes all thoracolumbar fractures regardless of the energy of trauma or if patients have fragility fractures i.e. osteoporosis. Unfortunately we could not extract if the patient has osteoporosis. The results have to be interpreted with caution due to the different risk factors in these subgroups (high energy trauma vs. osteoporosis). Geriatric high energy trauma is common and makes this analysis even more complex [38]. The type of injuries and outcomes associated with particular mechanisms of injury is therefore important to further study. Performing an evaluation during a longer time period will reflect time trends and the results of preventions of injuries will be possible to study.

In conclusion, our study gives new information on the burden of thoracolumbar vertebral fractures as well as important information about the surgical incidence and differences according to gender and age. This information should be taken into consideration in the planning of health care and when studies are planned.

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